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1938

Establishing a strength index norm table for women...

BOSTON UNIVERSITY

SCHOOL OF EDUCATION

THESIS

ESTABLISHING A STRENGTH INDEX NORM TABLE FOR WOMEN BETWEEN THE AGES OF TWENTY AND THIRTY-FIVE

Submitted by

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First Reader: Frederick R. Rogers, Professor of Education
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17265

C O N T E N T S

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CHARTS

INTRODUCTION

The purpose of this study has been to establish a strength index norm table for women between twenty and thirty-five years of age. This has been done with the hope that teachers of health education and physical education may find the results useful in determining and meeting the needs of young women.

To have assisted in the re-direction of a program of physical education in a public school, where the physical fitness index is used as a measure of health and as an additional means for determining the needs of pupils, and to have watched the amazing progress of the same, has convinced the writer of the inestimable value of this testing procedure. Because of the individualization, practicability, and productivity of this program, it has secured the active cooperation of school administrators, teachers, pupils, and parents. In fact, it has made the entire community health conscious.

In contrast to the above, to have had experience as director of physical education in several Young Women's Christian Associations in which the problem of measurement was omitted, has equally impressed the writer of the need of this particular study.

One of the great fields of service for physical educators lies in the opportunity to build power for health into the lives of young women out of "teen age". Those who have the opportunity to come in touch with this age group have the privilege of giving the kind

of leadership and guidance that will be of value to the individual.

There is need for us to concentrate our efforts on objectives: objectives which will provide a means of measuring health; which in so far as it is possible, will help individuals to have the physique and vitality which they ought to have; which will lead them to achieve a greater degree of health and hence a greater power for success and happiness. In one of Horace Mann's lectures on education is found this statement: "There is a higher art than the art of the physician--the art, not of restoring, but of making health. Health is a 'product'".

Every young woman wants to know her physical resources and, to a lesser extent, her mental resources. She is anxious to learn how to increase or to conserve her power for health; and how to obtain the best returns in terms of strength and vigor, happiness, and success. Surely, at regular intervals, she is interested in discovering whether or not she has been gaining or losing in health.

This testing procedure provides a simple, practicable, and economical means of determining individual needs. The physical fitness index, together with the medical examination, and the variety of facts which come to the surface at the time of testing, and in conference with the individual after the testing, give an accurate estimate of an individual's physical condition. Fluctuations from the norm for a given sex, age, and weight may be noted and taken into account. A

program may then be adapted to meet the physical, mental, and social needs of the individual concerned.

Surely, if we hope to secure dynamic public approval toward physical education, this individual approach which enables one to be busy with purposes vital to her is necessary.

SOURCE OF DATA

The data for this study were obtained from groups of women in several evening recreation centers, from Young Women's Christian Associations, and from women's physical education classes in Young Men's Christian Associations.

Since testing of this particular age group was a comparatively new adventure, it involved many difficulties. Although the physical capacity tests were familiar to the majority of those in charge of the physical education classes of the associations approached, they had not been used as a measure for determining the needs of women. In order to secure permission to administer the tests, it was necessary to spend considerable time in explaining their purpose and value to administrators and directors. It was encouraging to find that in almost every instance the opportunity to see the testing procedure, in action, was gladly welcomed.

The fact that the tests had not been previously given meant that the equipment was not at hand. Fortunately, that used in the Brookline Public Schools was generously offered for use in this study. This meant, however, that it had to be taken from one center to another, consequently, much time had to be spent in arranging the proper "set-up".

Finally, to approach these groups without having had the opportunity to explain or to demonstrate the tests, was not easy. It demanded patience and perseverance on the part of both the subjects and the examiners.

With these facts in mind, it was not surprising that more than a few evenings, which yielded very meagre results as far as numbers were concerned, were spent. However, the keen interest and enthusiasm of the various groups, their desire to know the amount of strength which was theirs, and their eagerness to find out what could be done to improve their physical fitness index, far out-weighed any discouragement which otherwise might have arisen.

Groups were tested in the following centers:

RECREATION CENTERS	
Brookline Municipal Gymnasium	17
Charlestown Evening School Center	9
Elizabeth Peabody House	7
Franklin Square House	8
TEACHERS COLLEGES AND UNIVERSITIES	
Boston University, Sargent School for Physical Education	36
Bridgewater State Teachers College	64
YOUNG MEN'S CHRISTIAN ASSOCIATIONS--WOMEN'S CLASSES	
Lynn	27
Malden	34
Melrose	14
Quincy	31
Wakefield	14
YOUNG WOMEN'S CHRISTIAN ASSOCIATIONS	
Boston	59
Providence	17
Worcester	63
MISCELLANEOUS GROUP	36

SAMPLE CARD

USED IN THIS STUDY

Name X					Date 3-11-38	
Group Bridgewater State Teachers College						
Age	20 y	6 m	y	m	y	m
Weight	113½					
Height	62½					
Multiplier		14				
Pullups	12½					
Pushups	5	18				
Arm Strength	1	12				
	1	4				
Lift-Legs	6	40				
Lift-Back	2	70				
Grip-Left		55				
Grip-Right		70				
Lung capacity	1	70				
STRENGTH INDEX	1457					
Normal S. I.	1260					
PHYSICAL FITNESS INDEX	115					

PHYSICAL CAPACITY TESTS

I. The physical capacity tests used in this study included seven measures:

1. Lung capacity
2.)
) Strength of forearms
3.)
4. Strength of back
5. Strength of legs
6. Strength of extensor muscles of arms
7. Strength of flexor muscles of arms

II. Throughtout the testing, the importance of the following points was not under-estimated:

1. The accurate calibration of instruments
2. The careful set-up of testing apparatus
3. The proper administration and observation of the tests by the examiners.

1. LUNG CAPACITY

By means of a "wet spirometer" the amount of air which it is possible to exhale from the lungs, in a forced exhalation, into the spirometer is measured in cubic inches. This represents the lung or vital capacity.

2. and 3. HAND GRIP or STRENGTH OF FOREARMS

The strength of each forearm is measured in pounds by a hand Dynomometer. The instrument is placed in the hand of the subject by the tester. The subject is then told to "grip" without allowing either hand to touch the body or any other supporting apparatus. Two trials are generally given, alternating left and then right; the better score for each is then recorded.

4. STRENGTH OF BACK

The strength of the back is measured in pounds by means of a back and leg dynomometer. Throughout the study, this test was given with the use of two straps, one end of each having been slipped over each wrist and the other end over the lifting bar. The straps were then grasped instead of the bar. This eliminated the difficulty of "hand slipping" and the necessity of any assistance being given by the examiner. The subject stood on the base of the dynomometer with feet parallel and about six inches apart, legs straight, body inclined slightly forward. The chain of the dynomometer was then adjusted to give the maximum tension on the dynomometer spring and the subject was told to "lift steadily until given the command 'Enough'". Unless the person being tested

felt that she had not done her best, or unless the score indicated some maladjustment, the result of the first trial was recorded.

5. STRENGTH OF LEGS

This was also measured in pounds by means of a back and leg dynomometer. Throughout the study this test was given with the use of the belt. The subject grasped the lifting bar in the center, hands close together, palms down. The belt was then brought around the pelvic girdle, one end being fastened securely over one end of the bar, the other being adjusted to the proper length over the other end of bar. The position of the belt is extremely important. The subject stood on the base of the dynomometer, with feet parallel and about six inches apart, knees slightly bent and at an angle of approximately 100 (one hundred) degrees between the thigh and leg, back straight and head erect. The chain was adjusted to give maximum tension on the dynomometer spring and the subject "lifted steadily until the limit of power was reached". The use of the belt eliminated much of the discomfort which, in the old method, resulted from carrying the weight on the thighs. Its use avoided also the necessity of any assistance being given by the tester, which method made it a much more satisfactory test both for the subject and the examiner.

6. STRENGTH OF ARMS -- EXTENSOR MUSCLES

The strength of the extensor muscles of the arms was measured by having the subject do "push-ups". With women the "push-ups" are given on a stall bar bench or some other supporting apparatus of

approximately the same height and width (8" x 18"). The subject grasped the sides of the bench and assumed a "front rest position"-- body supported by the hands and the balls of the feet. The elbows were bent until the upper part of the chest was close to the top of the stall bar bench. She then "pushed up" with arms, being careful not to change the line of the body. This was repeated as many times as possible. Throughout the performance of this test the subject must maintain a straight position of the body without any sagging at the waist.

7. STRENGTH OF ARMS -- FLEXOR MUSCLES

The strength of the flexor muscles of the arms and the shoulder girdle was measured by having the subject do "pull-ups". This test was given on parallel bars with the use of rings, or on a piece of apparatus attached to the stall bars, and especially devised for the purpose of "pull-ups". The subject then grasped the rings or the bars and assumed a rear fall-hang position with heels resting on the floor. The body was at a slight angle, arms straight. The arms were then bent until the forearms were at right angles with upperarms; the chin being on a level between the bar or rings. The arms were then extended, and the subject continued to repeat this process as many times as possible. Except on the last trial, half-way points were not counted. As in "push-ups", it was important to maintain a straight line of the body throughout the performance of this test.

CALCULATED SCORES FROM PHYSICAL CAPACITY TESTS

ARM STRENGTH

This score is obtained by adding the number of "push-ups" and "pull-ups" and multiplying the result by the following formula:

$$\frac{\text{Wt.}}{10} + \text{Ht.} - 60$$

ACHIEVED STRENGTH INDEX

The achieved strength index is computed by adding the results of the strength of arms, legs, back, left and right forearms, and the measure of the lung capacity.

PHYSICAL FITNESS INDEX

The physical fitness index is calculated by dividing one's achieved strength index by the normal strength index for the given sex, age, and weight. The result indicates the percentage which the individual is above or below the norm.

SIGNIFICANCE OF PHYSICAL FITNESS INDEX

Dr. Rogers has defined the physical fitness index as a "measure of one's physical condition". "The average individual less than twenty-one years of age will have a P.F.I. of about one hundred. Others less than twenty-one years of age will have P.F.I.'s varying from about forty to two hundred. Older people will decline in P.F.I. until, at death, their P.F.I. will be zero--as will be their powers to perform physical acts.

"Individuals with indices above one hundred will have a greater physical and mental endurance than those with lower scores. That is, to say, they will be able to keep going longer and more efficiently. They will be able to do more work in a given time than others of the same sex, weight, and age whose P.F.I.'s are lower. Also, they will recuperate faster from fatigue or illness.

"The lower the P.F.I., the greater the need for advice by physicians and physical educators. Low P.F.I.'s are the results of physical defects, improper food or eating habits, improper exercise, emotional disturbances, or other physical or mental strains or drains or injuries. Individuals with P.F.I.'s below eighty-five to ninety ought to engage in supervised remedial activities or rest daily, until their indices are one hundred or higher. Otherwise they are likely to decline steadily in physical fitness to even lower levels.

"Repeated P.F.I. tests are of inestimable value in determining

whether one is gaining or losing in physical fitness, and, therefore, whether one's corrective regime is adapted to one's needs. Many cases are on record of obscure defects and wrong habits, which escaped the attention of physicians and physical educators, being discovered through comparison of P.F.I. records. It is easily possible for individuals of almost any age to raise their P.F.I.'s from forty to one hundred per cent, with a proportionate increase in physical fitness, power for service and personal happiness." (1)

Ref.: (1) Statements by Dr. Frederick Rand Rogers.

CONSTRUCTION OF NORM TABLE

PROBLEM STATED

The construction of the norm table of strength indices for women between twenty and thirty-five years of age consisted of two main steps:

1. The determination of the normal strength index for the normal weight at each age based on the finding of the median strength index for the median weight at each age.
2. The determination of the strength increase with weight increase for each age.

The median was used as a measure of central tendency in preference to the arithmetic mean because of the fact that it avoided the excesses of extreme cases.

Intervals of one year were used as a basis for this study, since it was assumed that the variability in muscular strength was less with increase in age.

STATISTICAL TECHNIQUE

The statistical technique involved in the above determinations followed the procedure developed by Dr. Frederick Rand Rogers in his Dissertation, "Physical Capacity Tests in the Administration of Physical Education". (2)

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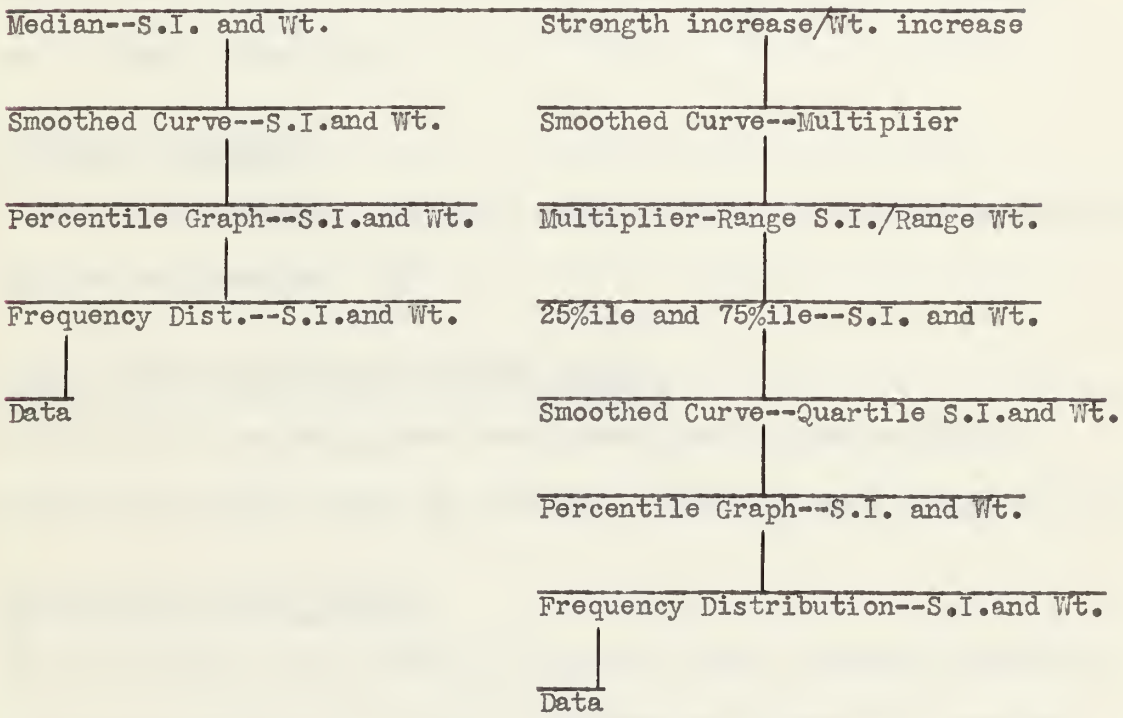
(2) Contributions to Education #173--Teachers College, Columbia University, Chapter VI--Pgs. 56-57.

PROCESS CHART OF THE PROBLEM

TABLE OF NORMS



The above chart pictures the procedure followed in the construction of the Norm Table.

STATISTICAL TECHNIQUE

PART I

DETERMINATION OF MEDIAN STRENGTH INDICES AND MEDIAN WEIGHTS AT EACH AGE

Frequency distributions of weights and strength indices were tabulated at each age. (Tables 1 and 2) From these frequency distributions the median weight and strength index at each age was determined using the graphic method (3). The median points were then plotted. (Charts 1 and 2--pages 21 and 22.)

SMOOTHING THE CURVE

The curve was smoothed using the method outlined in "Statistical Methods applied to Education". (4)

FINAL MEDIAN WEIGHTS AND STRENGTH INDICES

The results of smoothing the curve determined the new medians of weight and strength index at each age. (Tables 4 and 5--pages 23 and 24)

RELIABILITY OF THE MEDIANS

The reliability of the medians in terms of their standard deviations and the reliability of the median differences between the strength indices at all ages was checked by the methods outlined in "Statistics for Students of Psychology and Education" (5).

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(3) Herbert Sorenson, "Statistics for Students of Psychology and Education". Chapter 7, pages 105-109.
(4) H.O.Rugg, "Statistical Methods Applied to Education". Chapter 7, page 184.
(5) H. Sorenson, "Statistics for Students of Psychology and Education". Chapter 8, pages 138-144; Ch. 17, pages 311-314; Ch. 18, pages 327-331.

TABLE I

FREQUENCY DISTRIBUTION OF WEIGHT

WEIGHT	AGE											
	20	21	22	23	24	25	26	27	28	29	30	31-5
95-	1	-	2	1	-	-	-	-	-	-	-	-
96-99	5	1	1	2	-	-	-	1	-	-	-	2
100-03	-	3	1	1	2	3	-	-	-	-	-	2
104-07	8	5	3	-	-	-	2	2	3	-	-	-
108-11	6	4	4	1	3	1	2	2	2	-	1	5
112-15	3	3	5	2	4	3	1	3	5	1	2	4
116-19	14	10	3	1	1	1	1	1	2	4	1	6
120-23	4	15	5	3	2	4	1	2	-	1	-	1
124-27	7	9	2	3	6	1	3	1	4	4	1	5
128-31	-	2	2	3	1	-	1	1	2	4	2	4
132-35	6	1	5	3	2	4	-	2	-	2	1	5
136-39	9	3	5	4	2	3	-	2	1	-	3	4
140-43	7	5	7	5	1	-	-	-	1	-	-	2
144-47	4	3	2	4	2	1	-	1	-	2	2	2
148-51	2	1	3	-	-	-	1	2	-	-	-	1
152-55	1	-	-	1	2	2	1	-	1	-	-	1
156-59	-	1	-	-	-	-	1	-	2	-	1	1
160-over	4	2	1	1	1	-	1	4	2	1	1	3
Total Cases	81	68	51	35	29	23	15	24	25	19	16	51
75%ile	138.8	127.6	138.3	140.5	135.2	134.2	134.0	145.0	134.6	131.8	139.2	139.0
Median	122.0	121.8	127.1	131.3	124.8	122.3	123.7	127.0	119.2	124.9	132.0	127.5
25%ile	110.6	115.0	112.0	119.1	114.3	114.2	111.4	112.0	112.8	119.9	116.0	115.1
Range	28.2	12.6	26.3	21.4	20.9	20.0	22.6	33.0	21.8	11.9	23.2	23.9
Mean	126.2	124.6	126.2	125.5	127.5	125.1	128.6	130.5	127.2	130.8	130.3	129.5

TABLE II

FREQUENCY DISTRIBUTION OF STRENGTH INDEX

WEIGHT	AGE											
	20	21	22	23	24	25	26	27	28	29	30	31-35
799-	1	1	1	-	-	2	-	2	2	-	-	1
800-899	1	1	2	-	2	2	-	-	3	1	1	3
900-999	4	1	4	3	1	-	-	2	1	2	-	5
1000-1099	5	3	3	2	2	3	2	1	3	4	1	3
1100-1199	6	4	8	1	1	2	2	2	3	-	1	7
1200-1299	8	9	7	4	5	2	1	4	2	1	-	6
1300-1399	7	11	5	7	5	4	3	4	2	4	2	11
1400-1499	10	6	4	2	5	2	2	4	1	-	4	4
1500-1599	6	6	3	6	-	1	-	-	1	3	2	7
1600-1699	5	11	5	1	1	2	-	2	2	2	3	2
1700-1799	13	3	3	2	3	-	1	-	1	1	1	-
1800-1899	5	2	1	3	2	1	1	1	1	-	-	1
1900-1999	4	5	1	1	1	1	1	1	1	1	-	1
2000-over	6	5	4	3	1	1	2	1	2	-	1	-
Total Cases	81	68	51	35	29	23	15	24	25	19	16	51
75%ile	1770	1678	1594	1694	1612	1438	1790	1469	1624	1577	1641	1421
Median	1478	1480	1285	1413	1320	1300	1380	1308	1159	1343	1451	1293
25%ile	1230	1268	1121	1233	1158	1028	1162	1139	962	1027	1308	1083
Range	540	410	473	461	454	410	628	330	662	550	333	338
Mean	1503	1496	1377	1482	1401	1314	1530	1333	1321	1333	1462	1280

SAMPLE CALCULATION

(for age 21)

I. Standard deviation of the Frequency Distribution of the Strength Index

$$\sigma = i\sqrt{\frac{\Sigma fd^2}{N} - \left(\frac{\Sigma fd}{N}\right)^2}$$

$$= 100\sqrt{\frac{807}{68} - \frac{841}{4624}}$$

$$= 100\sqrt{11.867 - 0.181}$$

$$= 100\sqrt{11.686} = \underline{342}$$

II. Standard deviation of the Median Strength Index

$$\sigma Md = \frac{5/4\,\sigma}{\sqrt{N}}$$

$$= \frac{342 \times 5/4}{\sqrt{68}} = \frac{427}{83} = \underline{51.5}$$

III. Critical Ratio

$$C.R. = \frac{md_1 - md_2}{\sqrt{\sigma md_1^2 + \sigma md_2^2}}$$

$$= \frac{1480 - 1478}{\sqrt{45.8^2 + 51.5^2}}$$

$$= \frac{2}{\sqrt{2098 + 2652}} = \frac{2}{\sqrt{4750}} = \underline{.03}$$

The results of the above calculations at each age are listed in Talbe III, page 20.

TABLE III

STANDARD DEVIATIONS AND CRITICAL RATIO

OF STRENGTH INDICES FOR EACH AGE

AGE	MEDIAN	NO.CASES	STD.DEV.	MED.S.D.	CRITICAL RATIO
20	1478	81	330	45.8	
21	1480	68	342	51.5	.03
22	1285	51	337	59.2	2.48
23	1413	35	311	65.8	1.45
24	1320	29	311	71.9	.95
25	1300	23	360	93.8	.16
26	1380	15	305	97.6	.59
27	1308	24	327	83.5	.56
28	1159	25	399	99.7	1.14
29	1343	19	334	95.0	1.33
30	1451	16	276	86.2	.84
31-35	1293	51	258	45.5	1.61

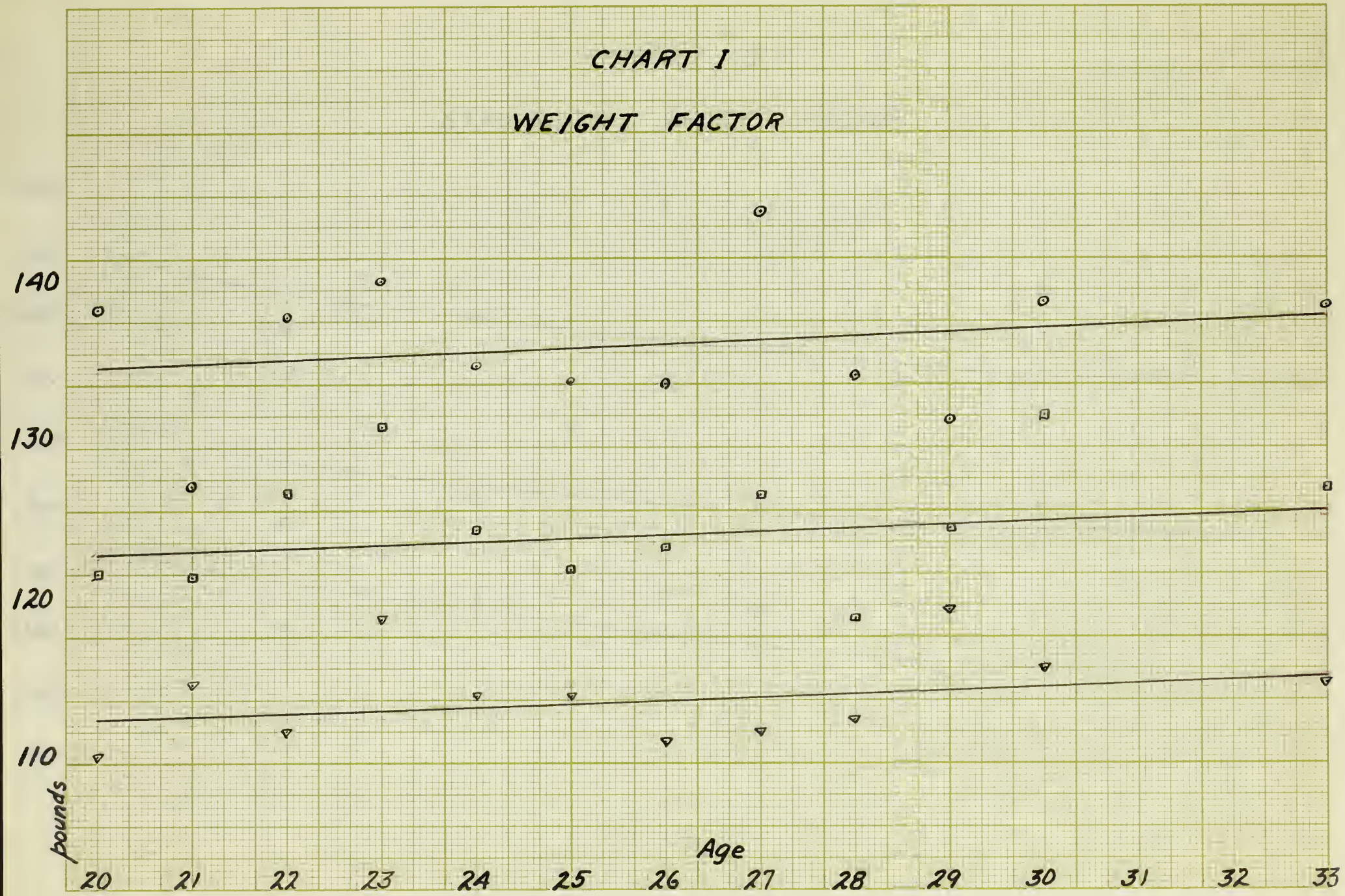
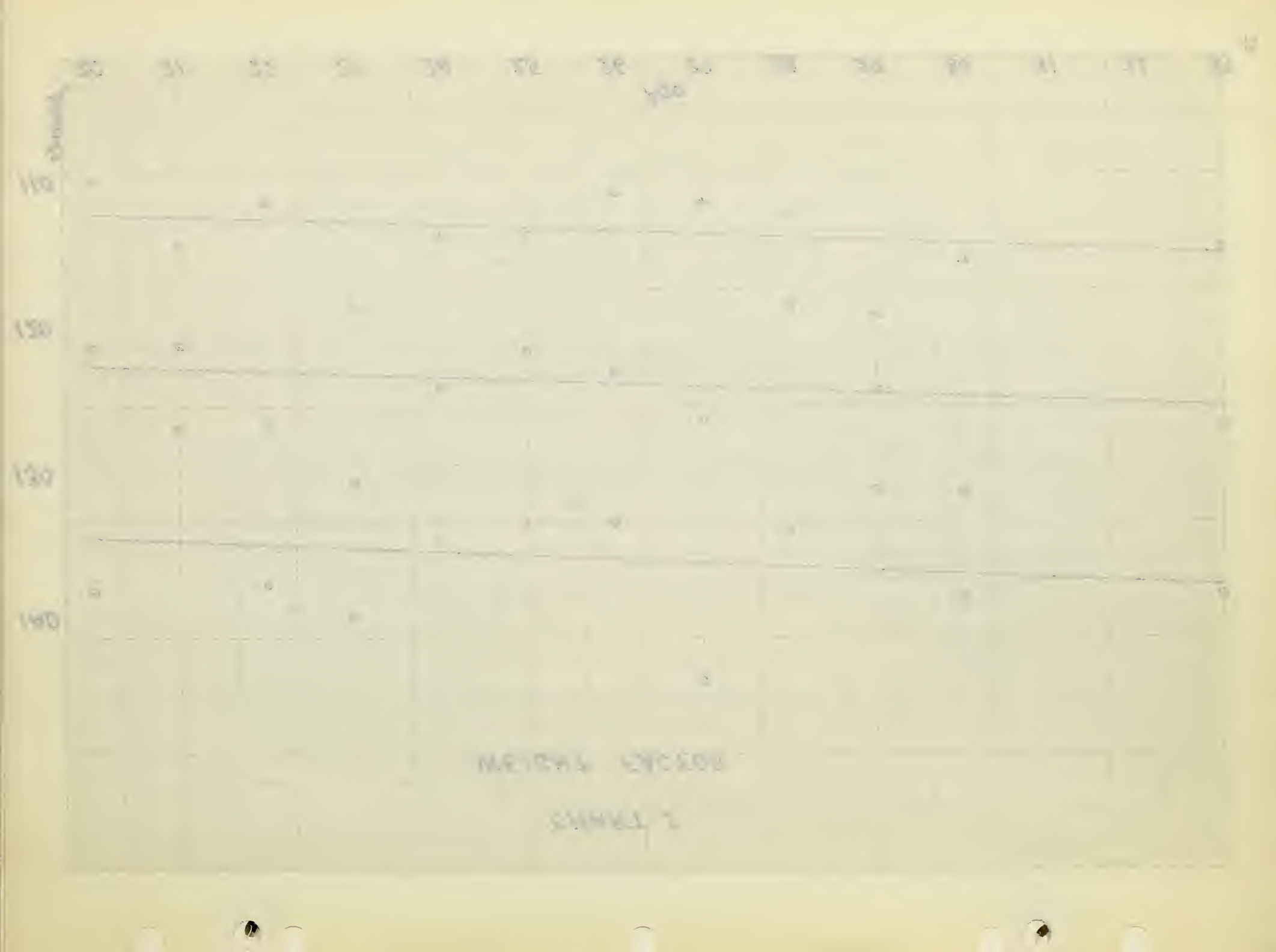


CHART I
WEIGHT FACTOR
140
130
120
110
pounds
Age
20
21
22
23
24
25
26
27
28
29
30
31
32
33



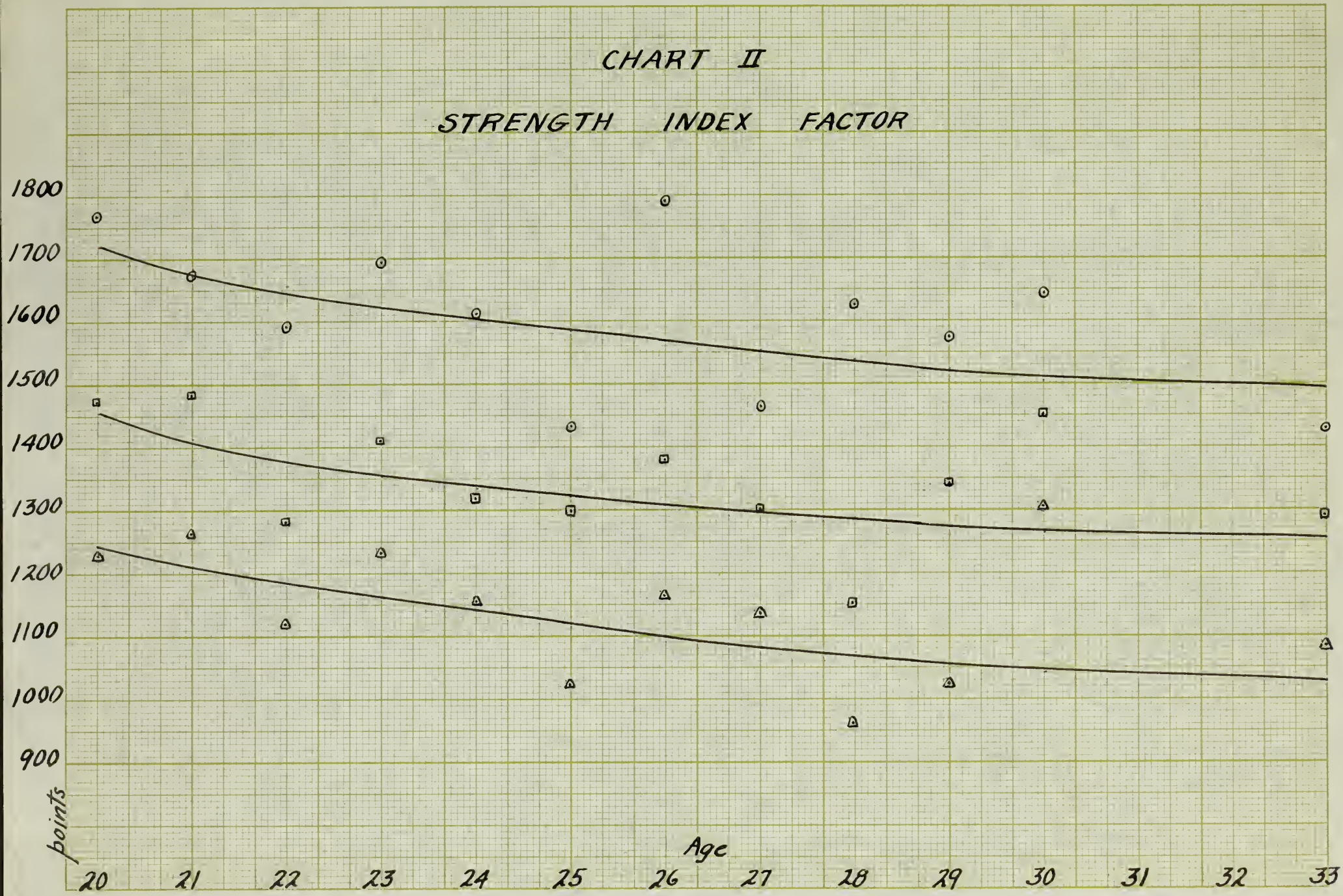


CHART II
STRENGTH INDEX FACTOR
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
points
Age
20
21
22
23
24
25
26
27
28
29
30
31
32
33

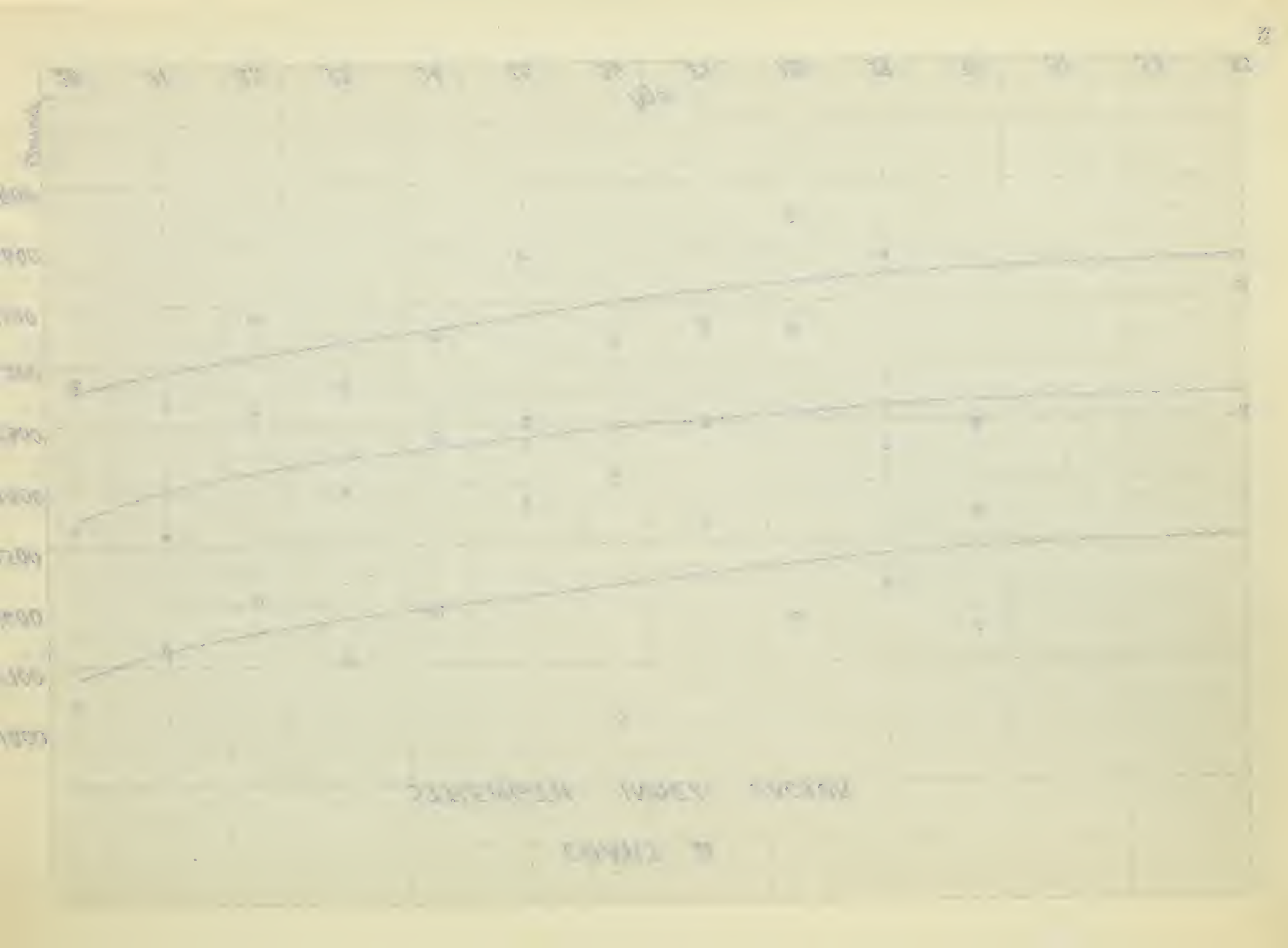


TABLE IV

QUARTILE FIGURES OF THE WEIGHT FACTOR

AFTER THE CURVES WERE SMOOTHED

Age	25%ile	Median	75%ile	Range
20	112.9	123.2	135.0	22.1
21	113.2	123.5	135.3	22.1
22	113.4	123.6	135.6	22.2
23	113.6	123.9	136.0	22.4
24	113.8	124.2	136.2	22.4
25	114.0	124.5	136.5	22.5
26	114.3	124.7	136.7	22.4
27	114.4	124.9	137.1	22.7
28	114.7	125.2	137.4	22.7
29	114.9	125.4	137.6	22.7
30	115.2	125.6	137.9	22.7
31-35	115.4	126.0	138.3	22.9

TABLE V

QUARTILE FIGURES OF THE STRENGTH FACTOR

AFTER THE CURVES WERE SMOOTHED

AGE	25%ile	MEDIAN	75%ile	RANGE
20	1234	1457	1720	486
21	1211	1419	1685	474
22	1188	1380	1656	468
23	1169	1357	1621	452
24	1141	1333	1609	468
25	1119	1323	1588	469
26	1100	1310	1570	470
27	1084	1300	1554	470
28	1072	1290	1540	468
29	1058	1279	1523	465
30	1042	1269	1509	467
31-35	1030	1258	1493	463

MATHEMATICAL CHECK OF SMOOTHED MEDIAN STRENGTH INDEX CURVE

The median strength index at the median weight of age twenty years was assumed as a base. From this the median strength index at each age was adjusted to the median weight of twenty years by (1) multiplying the difference between the median weight of twenty-one years and the median weight of twenty years by the weight deviation multiplier of twenty-one years; (2) subtracting the result from the median strength index of twenty-one years. The result represents the strength index of a person twenty-one years of age weighing 123.2 pounds.

SAMPLE CALCULATION

DATA

Median Strength Index	Age 21 -- 1419
Median Weight	Age 21 -- 123.5
Median Weight	Age 20 -- 123.2
Weight deviation multiplier	Age 21 -- 21.3

FORMULA

Adjusted strength index (Age 21) =

$$\underset{21}{\text{Med. S.I.}} \text{ minus } (\underset{21}{\text{Med. Wt.}} \text{ minus } \underset{20}{\text{Med.Wt.}}) \underset{21}{\text{Multiplier}}$$

1419 minus (123.5 minus 123.2) 21.3

1419 mimus (.3 x 21.3)

1419 minus 6.4 = 1413 = $\underset{21}{\text{Adjusted S.I.}}$

The above procedure was followed for each age and the results were listed in Table VI. (Page 26)

The adjusted strength indices were smoothed mathematically by the method outlined in "Statistical Methods Applied to Education" (5a) and the results listed in Table VII. (Page 27)

RESULTS OF MATHEMATICAL CHECK

OF SMOOTHED MEDIAN STRENGTH INDEX CURVE

TABLE VI

Age	Median Weight	Median S.I.	Weight Dev. Multiplier	Diff. in Pounds	Adjusted S.I.
20	123.2	1457	21.40	.0	1457
21	123.5	1419	21.30	.3	1413
22	123.6	1380	21.20	.4	1372
23	123.9	1357	21.10	.7	1342
24	124.2	1333	21.00	1.0	1312
25	124.5	1323	20.90	1.3	1296
26	124.7	1310	20.80	1.5	1279
27	124.9	1300	20.70	1.7	1265
28	125.2	1290	20.60	2.0	1249
29	125.4	1279	20.50	2.2	1234
30	125.6	1269	20.40	2.4	1220
31-35	126	1258	20.30	2.8	1201

(5a) H. O. Rugg "Statistical Methods Applied to Education Chapter 7, page 184

TABLE VII

RESULTS OF MATHEMATICAL CHECK

OF SMOOTHED MEDIAN STRENGTH INDEX CURVE

(Smoothed Figures from Table VI)

AGE	S.I. at 123.2 Smoothed	First Diff.	Second Diff.
20	1457		
21	1414	43	
22	1376	38	5
23	1342	34	4
24	1317	25	9
25	1296	21	4
26	1280	16	5
27	1264	16	0
28	1249	15	1
29	1234	15	0
30	1219	15	0
31-35	1208	11	4

PART II

DETERMINATION OF THE STRENGTH INCREASE WITH THE WEIGHT INCREASE FOR EACH AGE

DETERMINATION OF TWENTY-FIFTH AND SEVENTY-FIFTH PERCENTILES

From the same percentile graphs which were used in Part I for the purpose of finding the median strength index and the median weight at each age, the twenty-fifth and seventy-fifth percentiles were determined for weight and strength index and the points plotted. (Charts I and II, pages 21 and 22)

SMOOTHING THE CURVE

The curve was smoothed again using the method outlined in "Statistical Methods Applied to Education" (6) and the new inter-quartile points in strength index and weight at each age were determined and tabulated. (Tables IV and V, pages 23 and 24)

INTER-QUARTILE RANGES

The range of the strength index and weight at each age was computed by subtracting the twenty-fifth percentile from the seventy-fifth percentile at each age. The results of this procedure are listed in Tables IV and V, pages 23 and 24)

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(6) H.O.Rugg, "Statistical Methods Applied to Education" Chapter VII, page 184.

"Increase in Strength Index Points per increase in one pound of weight for each age." (7)

The increase in strength index points per increase in one pound of weight for each age was found by dividing the range in strength index points by the range in weight at each age. (Table VIII, page 29)

TABLE VIII

WEIGHT DEVIATION MULTIPLIER

(Unsmoothed curve)

AGE	MULTIPLIER
20	21.5
21	21.4
22	21.0
23	20.1
24	20.8
25	20.8
26	21.0
27	20.7
28	20.6
29	20.5
30	20.5
31-35	20.2

(7) F.R.Rogers, "Physical Capacity Tests in the Administration of Physical Education", page 57.

DETERMINATION OF FINAL WEIGHT DEVIATION MULTIPLIER

The points of the weight deviation multipliers from the unsmoothed curve (Table VIII) were then plotted (Chart III) and the curve smoothed by observation. The results gave the final weight deviation multiplier. (Table IX, page 30)

TABLE IX

FINAL WEIGHT DEVIATION MULTIPLIER

(Smoothed)

AGE	MULTIPLIER
20	21.4
21	21.3
22	21.2
23	21.1
24	21.0
25	20.9
26	20.8
27	20.7
28	20.6
29	20.5
30	20.4
31	20.3
32	20.2
33	20.1

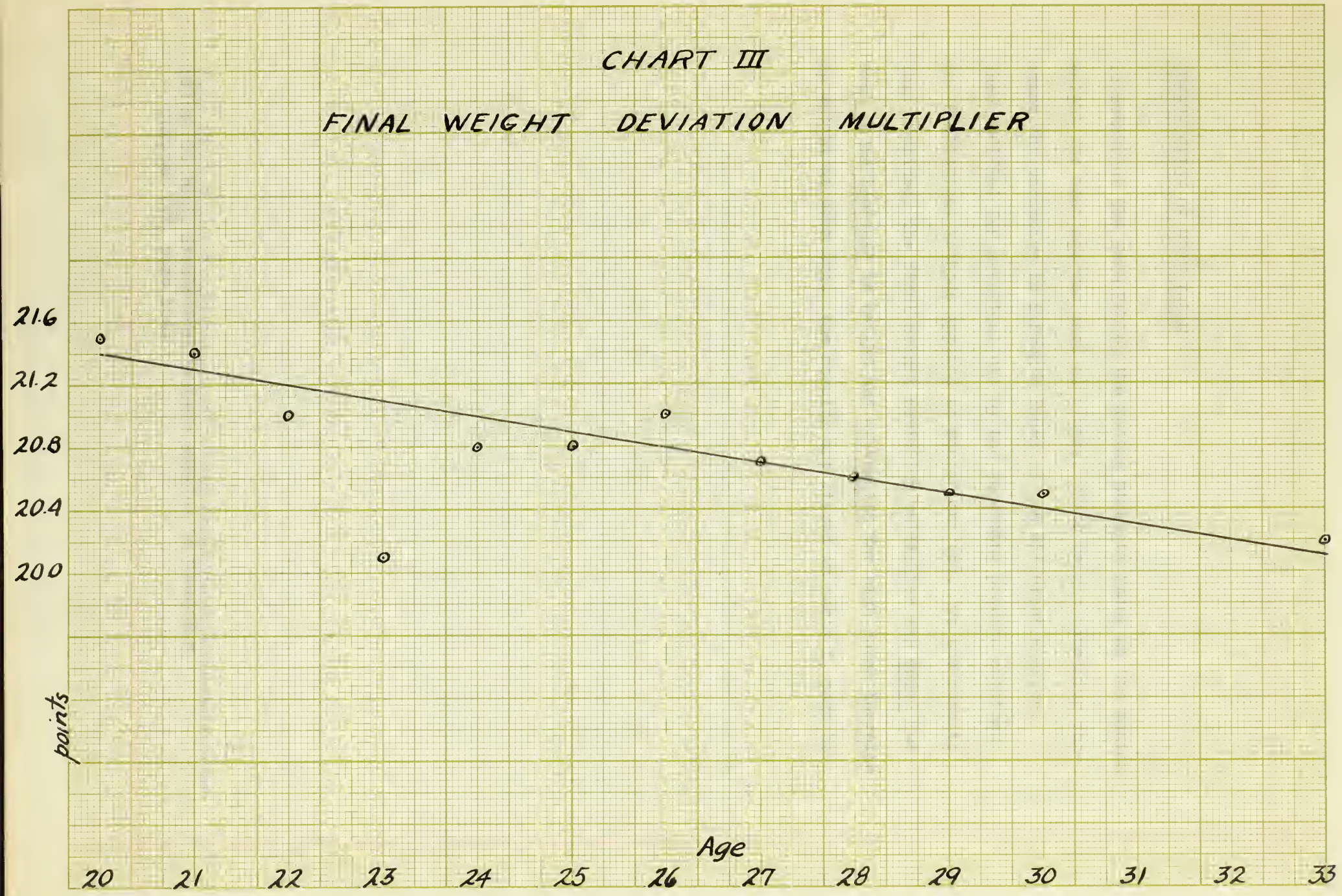


CHART III
FINAL WEIGHT DEVIATION MULTIPLIER
21.6
21.2
20.8
20.4
20.0
points
Age
20
21
22
23
24
25
26
27
28
29
30
31
32
33

CONSTRUCTION OF NORM TABLE

To construct the Norm Table, the median Strength Index at the median weight for each age was used as a base. With weight remaining constant the variation in Strength Index at the different ages was then modified for practical use by the smoothing process outlined in "Statistical Methods Applied to Education" (8). To the results thus obtained, the final weight deviation multiplier was added for each pound increase in weight and subtracted for each pound decrease in weight at each age. The results are listed in Table X, page 33.

(8) H. O. Rugg, Statistical Methods Applied to Education, Chapter VII, page 184.

TABLE X

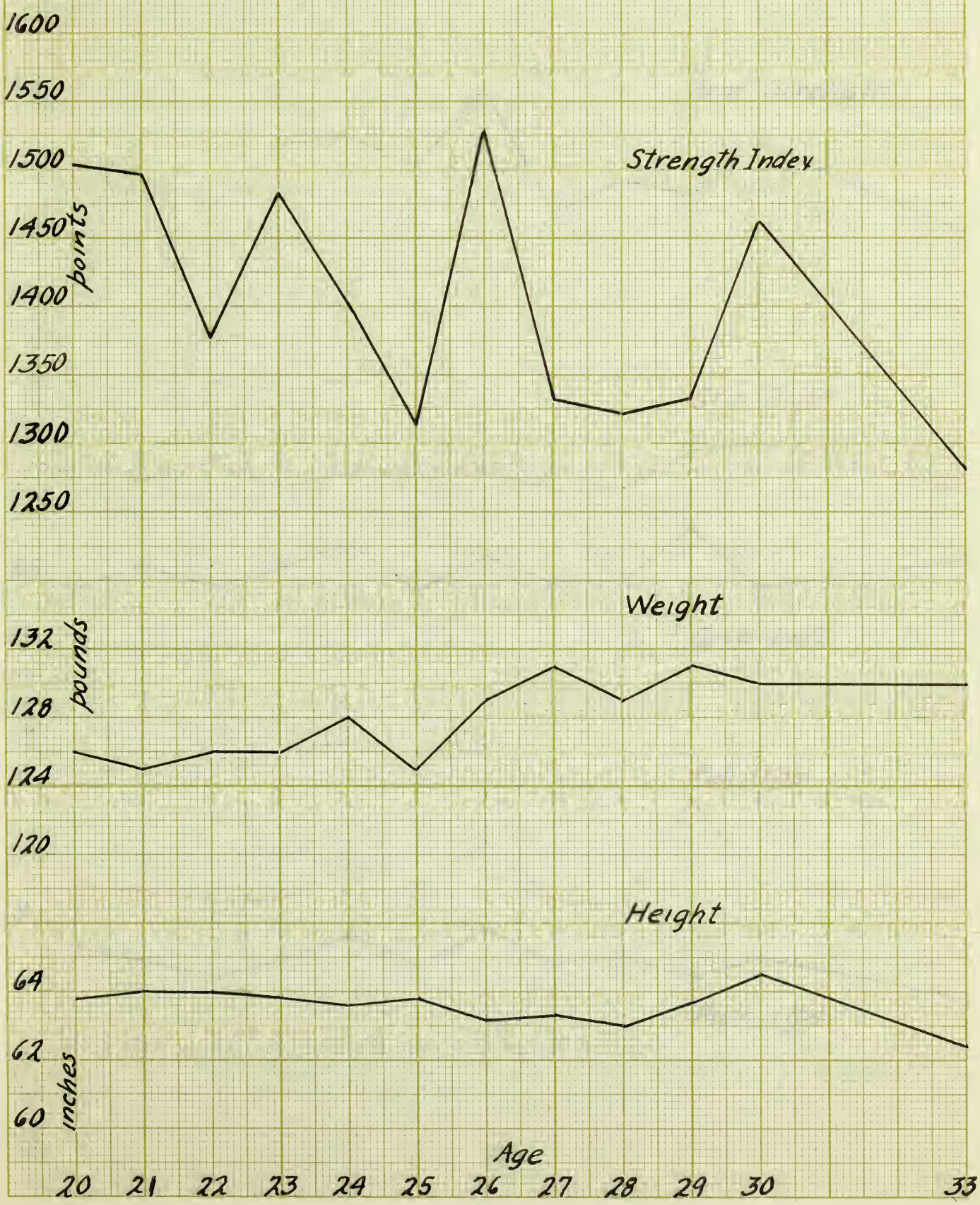
TABLE OF NORMS

Wt.	Age													
	20	21	22	23	24	25	26	27	28	29	30	31	32	33
178								2401	2381	2361	2343	2334	2327	2319
176							2380	2359	2340	2320	2302	2294	2286	2279
174						2362	2338	2318	2298	2279	2262	2253	2246	2238
172					2347	2320	2297	2276	2257	2238	2221	2213	2205	2198
170				2336	2305	2278	2255	2235	2216	2197	2180	2172	2165	2158
168			2328	2294	2263	2236	2213	2194	2175	2156	2139	2131	2125	2118
166		2316	2285	2252	2221	2194	2172	2152	2134	2115	2098	2091	2084	2078
164	2294	2273	2243	2209	2179	2153	2130	2111	2092	2074	2058	2050	2044	2037
162	2251	2231	2200	2167	2137	2111	2089	2069	2051	2033	2017	2010	2003	1997
160	2208	2188	2158	2125	2095	2069	2047	2028	2010	1992	1976	1969	1963	1957
158	2165	2145	2116	2083	2053	2027	2005	1987	1969	1951	1935	1928	1923	1917
156	2122	2103	2073	2041	2011	1985	1964	1945	1928	1910	1894	1888	1882	1877
154	2080	2060	2031	1998	1969	1944	1922	1904	1886	1869	1854	1847	1842	1836
152	2037	2018	1988	1956	1927	1902	1881	1862	1845	1828	1813	1807	1801	1796
150	1994	1975	1946	1914	1885	1860	1839	1821	1804	1787	1772	1766	1761	1756
148	1951	1932	1904	1872	1843	1818	1797	1780	1763	1746	1731	1725	1721	1716
146	1908	1890	1861	1830	1801	1776	1756	1738	1722	1705	1690	1685	1680	1676
144	1866	1847	1819	1787	1759	1735	1714	1697	1680	1664	1650	1644	1640	1635
142	1823	1805	1776	1745	1717	1693	1673	1655	1639	1623	1609	1604	1599	1595
140	1780	1762	1734	1703	1675	1651	1631	1614	1598	1582	1568	1563	1559	1555
138	1737	1719	1692	1661	1633	1609	1589	1573	1557	1541	1527	1522	1519	1515
136	1694	1677	1649	1619	1591	1567	1548	1531	1516	1500	1486	1482	1478	1475
134	1652	1634	1607	1576	1549	1526	1506	1490	1474	1459	1446	1441	1438	1434
132	1609	1592	1564	1534	1507	1484	1465	1448	1433	1418	1405	1401	1397	1394
130	1566	1549	1522	1492	1465	1442	1423	1407	1392	1377	1364	1360	1357	1354
128	1523	1506	1480	1450	1423	1400	1381	1366	1351	1336	1323	1319	1317	1314
126	1480	1464	1437	1408	1381	1358	1340	1324	1310	1295	1282	1279	1276	1274
124	1438	1421	1395	1365	1339	1317	1298	1283	1268	1254	1242	1238	1236	1233
122	1395	1379	1352	1323	1297	1275	1257	1241	1227	1213	1201	1198	1195	1193
120	1352	1336	1310	1281	1255	1233	1215	1200	1186	1172	1160	1157	1155	1153
118	1309	1293	1268	1239	1213	1191	1173	1159	1145	1131	1119	1116	1115	1113
116	1266	1251	1225	1197	1171	1149	1132	1117	1104	1090	1078	1076	1074	1073
114	1224	1208	1183	1154	1129	1108	1090	1076	1062	1049	1038	1035	1034	1032
112	1181	1166	1140	1112	1087	1066	1049	1034	1021	1008	997	995	993	992
110	1138	1123	1098	1070	1045	1024	1007	993	980	967	956	954	953	
108	1095	1080	1056	1028	1003	982	965	952	939	926	915	913		
106	1052	1038	1013	986	961	940	924	910	898	885	874			
104	1010	995	971	943	919	899	882	869	856	844				
102	967	953	928	901	877	857	841	827	815					
100	924	910	886	859	835	815	799	786						
98	881	867	844	817	793	773	757							
*	21.4	21.3	21.2	21.1	21.0	20.9	20.8	20.7	20.6	20.5	20.4	20.3	20.2	20.1

* Weight Deviation Multiplier

CHART IV

MEAN SCORES of TEST FACTORS



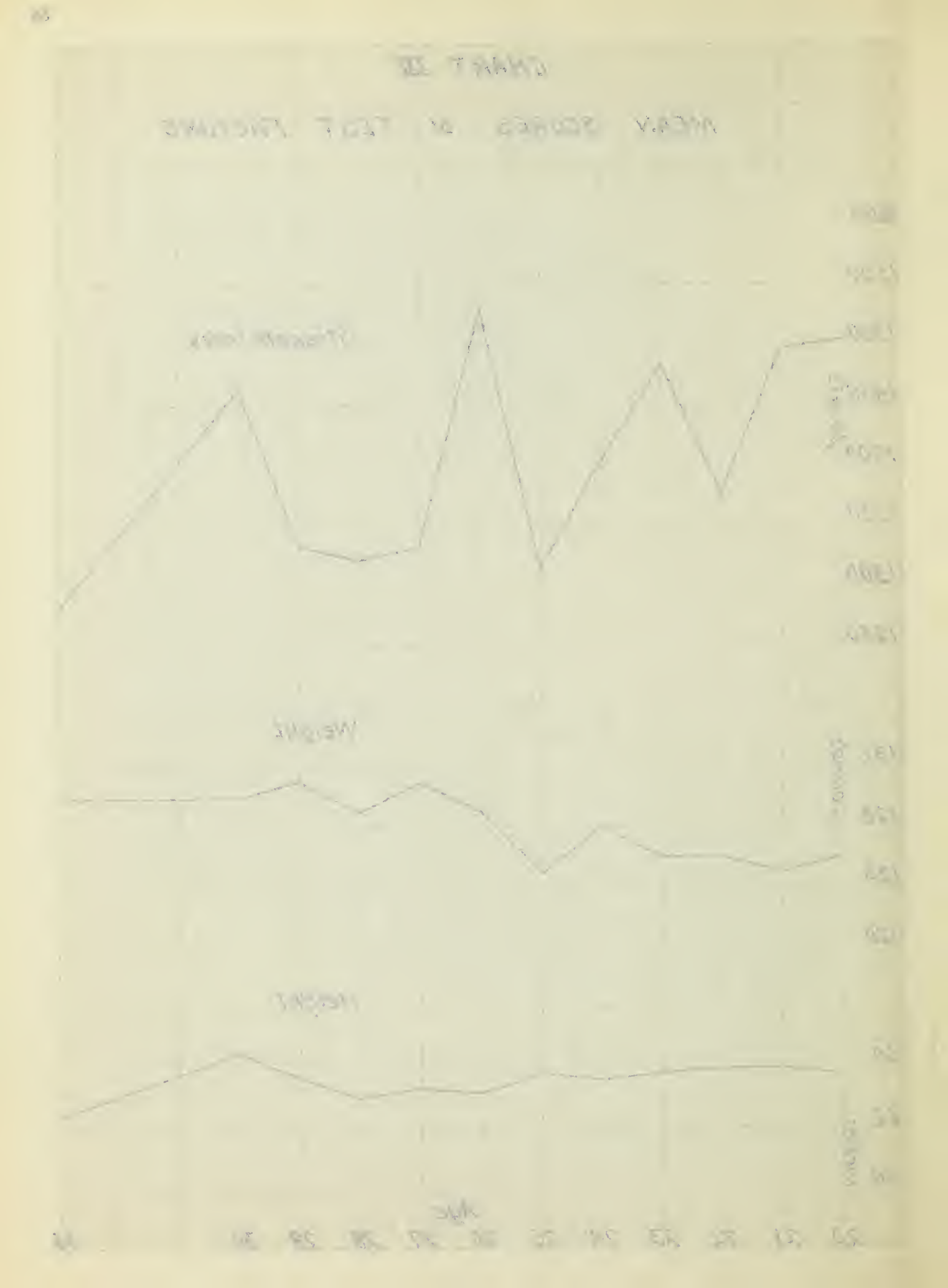
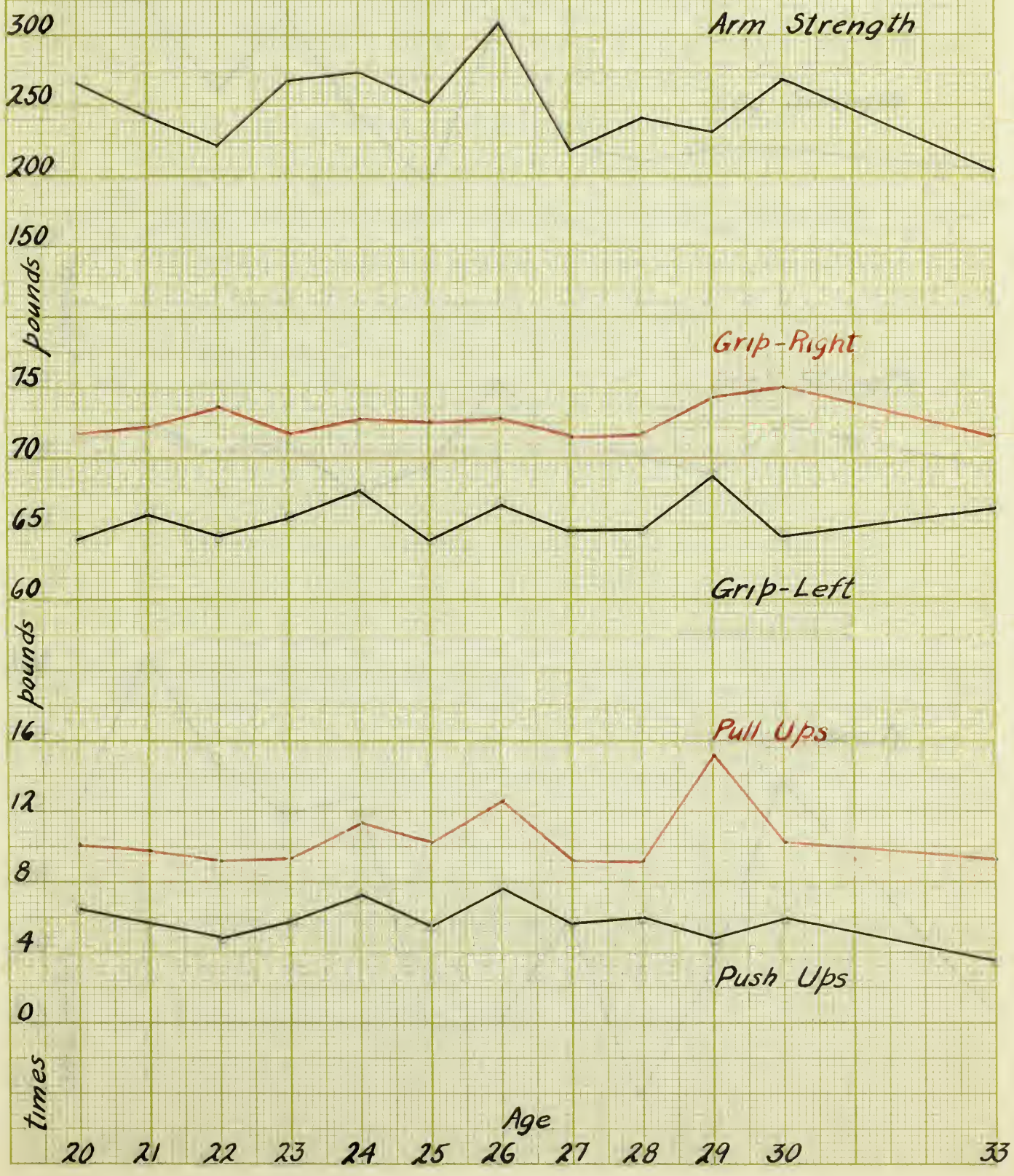


CHART V

MEAN SCORES of TEST FACTORS



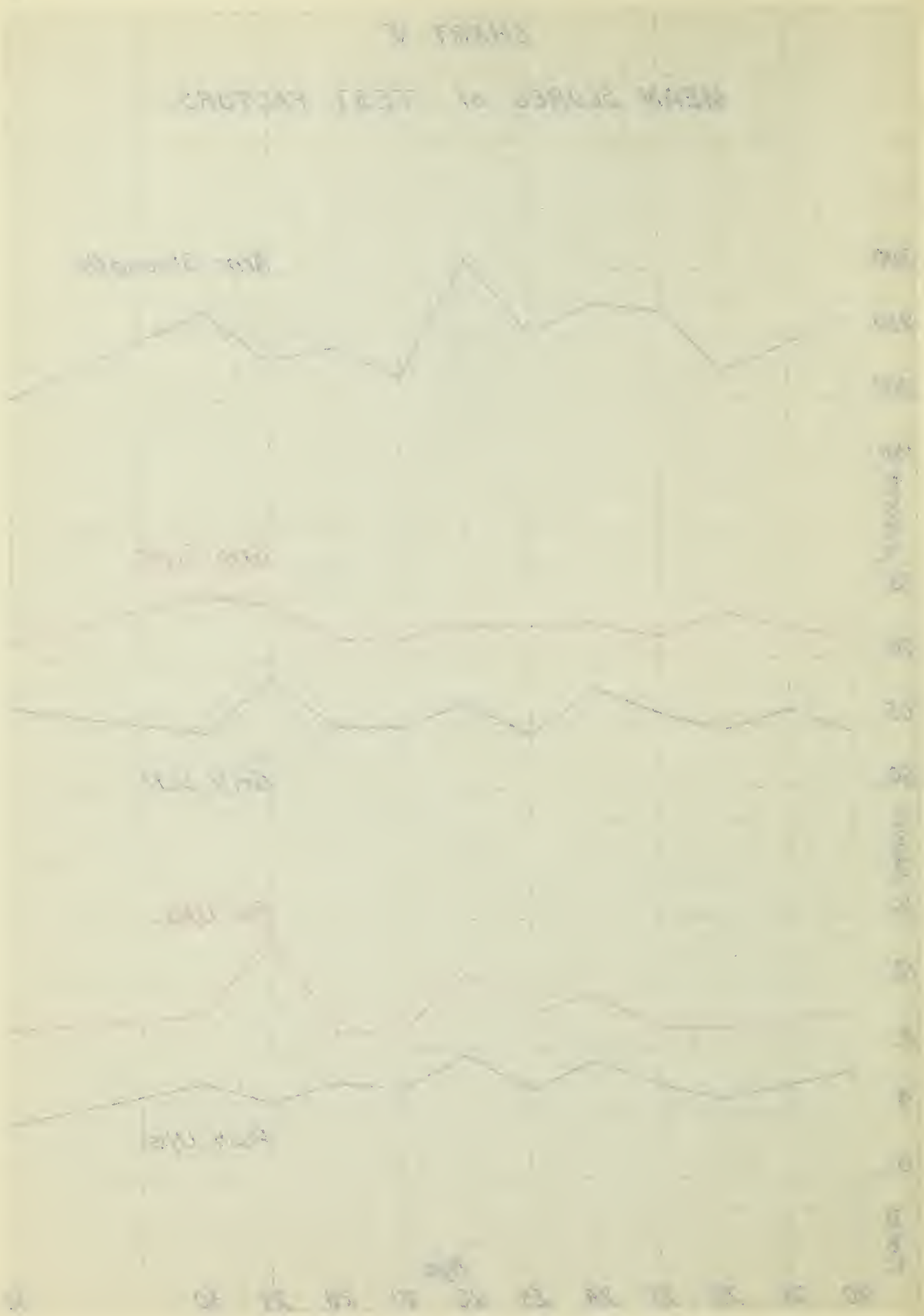
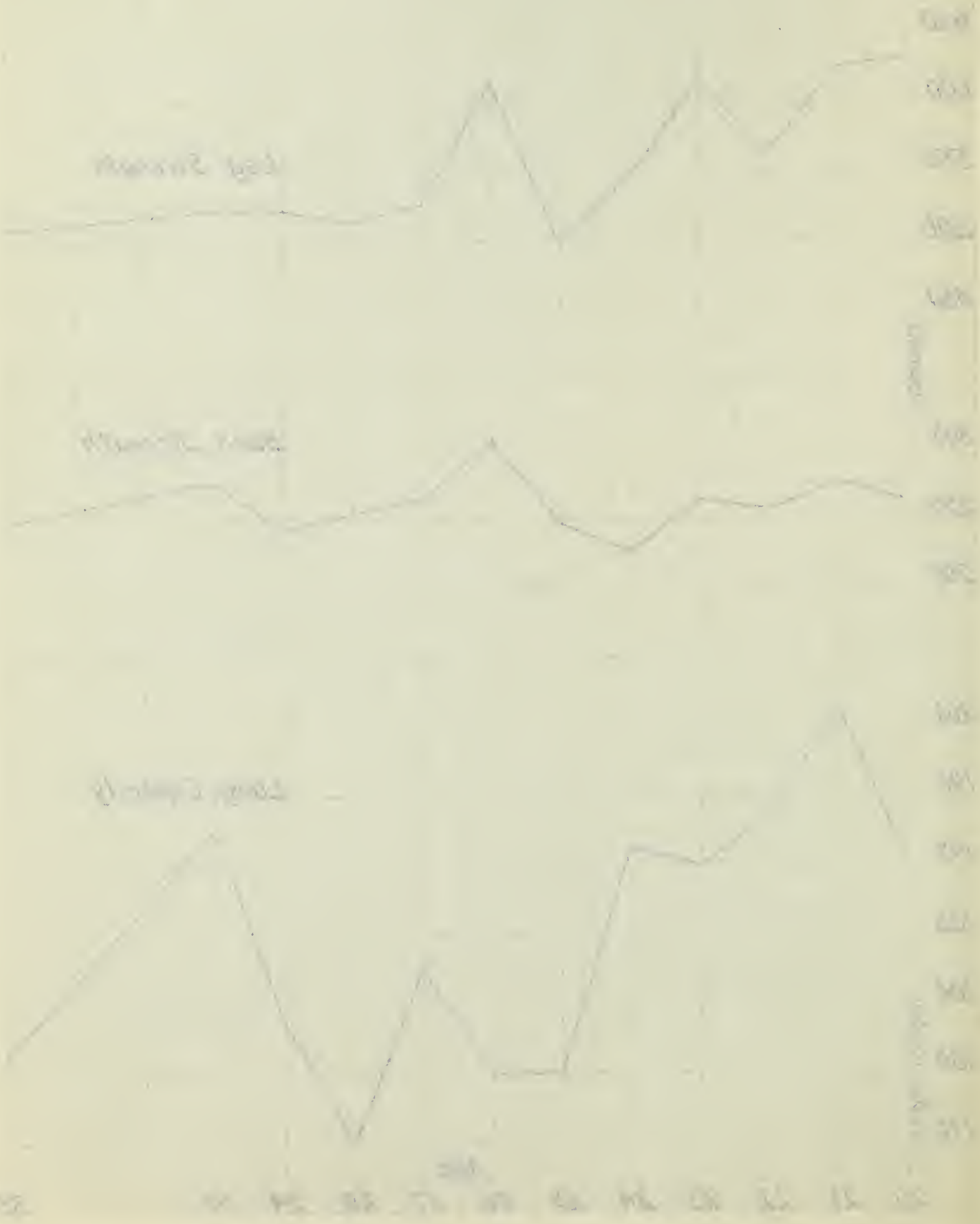


CHART VI

MEAN SCORES of TEST FACTORS

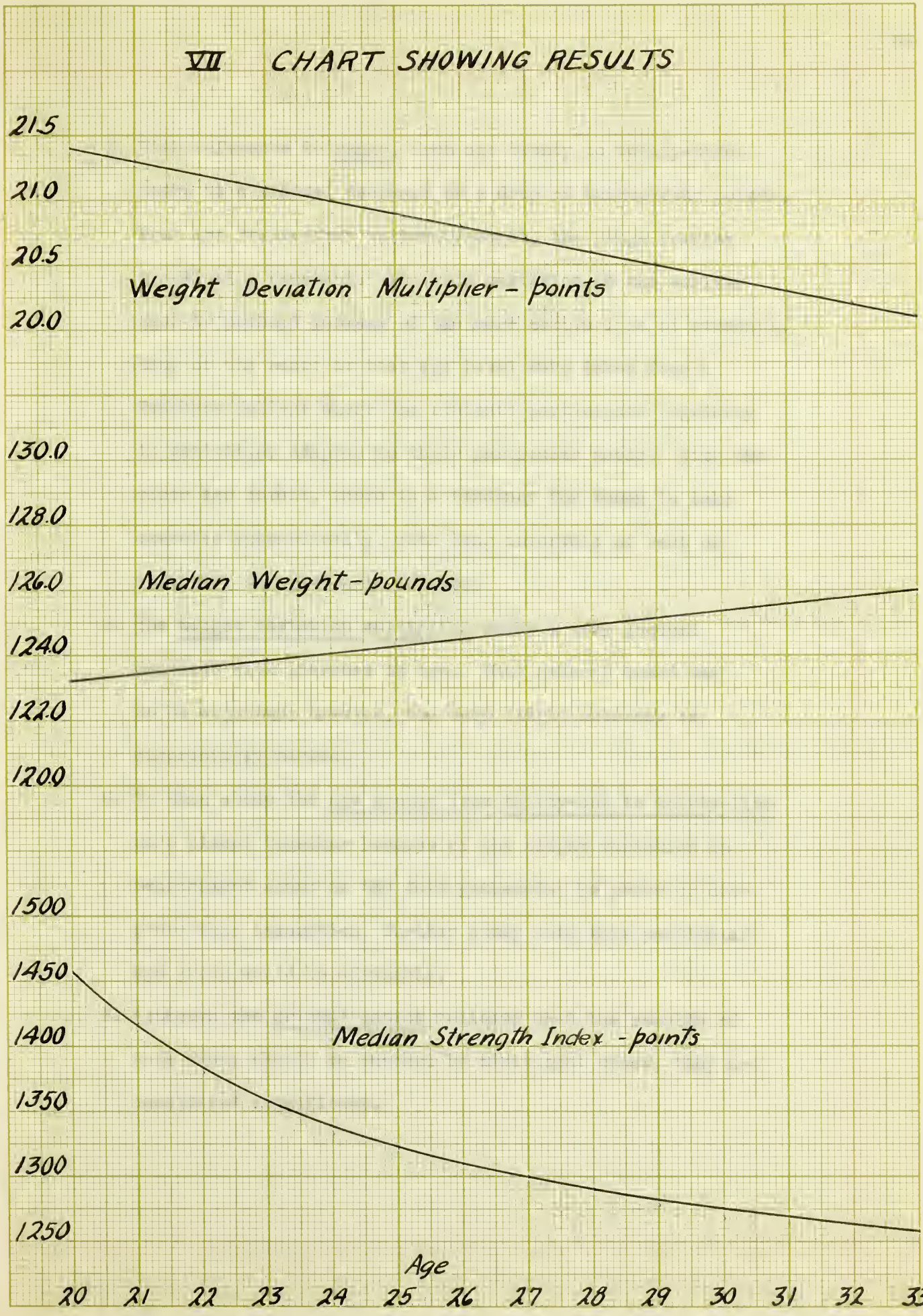


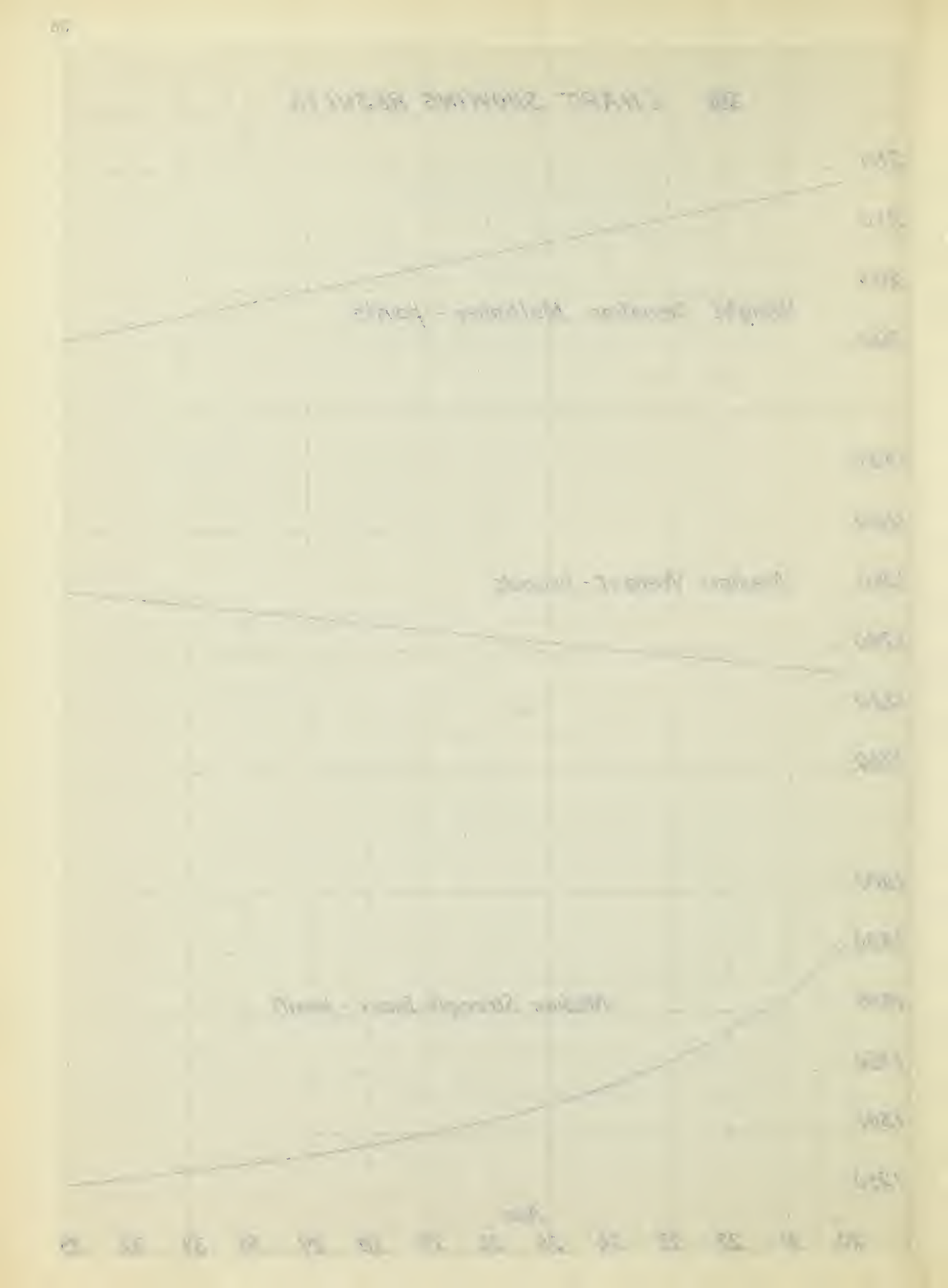
ANALYSIS AND CONCLUSIONS

From observation of the results of this study the following points are significant:

1. The first has reference to the weight factor. Although there is a gradual increase in weight with increase in age, it is not as marked as the writer expected it to be. One reason for this is because women are intelligently thinking of diet and exercise in terms of the effect which these two factors have upon weight, health, and power for efficiency.
2. With the strength factor there is a steady decrease in the median strength index, it being much more marked, however, between the ages of twenty and twenty-three. At age twenty-three the median strength index begins to level off and from there on it continues to decrease. Statistically, the median strength index from twenty to twenty-three years of age drops one hundred points, from 1457 to 1357; whereas from twenty-three to thirty-three years of age, a period of ten years, it drops only 99 points, from 1357 to 1258.
3. Further observation of the results show, that at age thirty, each of the interquartile points are exceptionally high. This discrepancy is undoubtedly because of the small number of cases at this age level.

VII CHART SHOWING RESULTS





4. With reference to range, from age twenty to twenty-three there is a gradual decrease or a drop of thirty-four points. From age twenty-four to twenty-eight, the range remains practically constant. The wide variation in the earlier ages is perhaps because of the more active life of students. Many of the cases at that age level were taken from a Teachers College where the students participate regularly in activities adapted to their particular needs. With the older age levels, there is a tendency for women to take exercise spasmodically, with long intervals of rest or sedentary occupation in between.
5. The weight deviation multiplier shows a very gradual decrease with increase in age. This general trend was to be expected; however, the very slight decrease is surprisingly marked.
6. In this study the age groups from thirty-one to thirty-five were placed together because of the slight variation in measurement shown in the data gathered. To prove or disprove this assumption, further study with this particular age group would be advisable.
7. Although the Cricial Ratios indicate that the results of this study should be checked by additional cases, they are considered significant.

8. From definite observation the writer believes that the belt technique in measuring the strength of the legs is far superior to any other method yet developed. Since it eliminates much of the discomfort of the previous method, and since there is no necessity of aid from the tester, the results give a truer score of the strength of the legs. With this improved technique the test may be easily used with women.
9. Throughout this study the writer has been impressed not only by the keen desire of the individuals tested to know their physical fitness index, but also by the interest of the teachers in the problem of measurement. Because of these two facts she believes that further emphasis should be placed on this testing procedure as a measure of health.
10. The writer hopes that because of this thesis teachers of health and physical education will be provided with this valid and objective method of determining the general needs of women; also, she trusts that leaders in Young Women's Christian Associations, and similar organizations, will be encouraged to use the results of the physical fitness index tests as a basis for adjusting programs to serve individual needs.

BIBLIOGRAPHY

Greene, Harry A.

Work Book in Educational Measurements
Longmans, Green & Co., N. Y., 1929

Hetherington, Clark W.

The Relation of Physical Education to Health
N. Y. University Press

Laveaga, Robert E.

Extension of the Strength Index Norm Table for Men
Boston University, School of Education, 1937

Lawton, Shailer Upton and Rogers, Frederick Rand

Educational Paths to Virtue
The Pleiades Co., Newton, Mass.

Maskell, S. S.

Revision of the Strength Index Norms for Boys
Boston University, School of Education, 1937

Rogers, Frederick Rand

Physical Education: A Resume for the Educational Administrator
University of the State of New York, 1927

Rogers, Frederick Rand

Educational Objectives of Physical Activity
A. S. Barnes & Co., 1929

Rogers, Frederick Rand

Fundamental Administrative Measures in Physical Education
Pleiades Co., Newton, Mass.

Rogers, Frederick Rand

Physical Capacity Tests in the Administration of Physical Education
Contributions to Education #173, Teachers College, Columbia University, 1926

Rugg, Harold O.

Statistical Methods Applied to Education
Houghton Mifflin Co.

Sorenson, Herbert

Statistics for Students of Psychology and Education
McGraw-Hill Book Co.

Watson, Goodwin B.

A Digest of the "Philosophy of Physical Education"
Journal of Health and Physical Education, Vol. 2,
Sept. 1931, pages 3--48